Dipoles and Bond Polarity

Go to www.phet.colorado.edu and search for the “Molecule Polarity” simulation

Use this screen to answer the following questions:

1. Change the electronegativities of both A and B. Which direction does the arrow for the bond dipole point?

   to the more electronegative atom

2. What do you notice about the length of the arrow for the bond dipole as you change the electronegativities?

   the arrow gets bigger when there is a bigger difference in electronegativities

3. Click on the box for “Electron Density”. What do you notice about the dispersion of electrons when...
   a. The 2 atoms have the same electronegativity values.

      the electrons are evenly dispersed

   b. The 2 atoms have different electronegativity values.

      the electrons are more dense around the atom with the higher electronegativity

4. Click on the box for “Partial Charges”. What do you think the “δ” represents?

   slightly or partially

   a. Which side of the molecule ends up being slightly negative?

      the more electronegative side
5. Explain how the bond dipole is different from the molecular dipole.

the bond dipole is between 2 atoms
the molecular dipole considers all bond dipoles
to give the polarity of the entire molecule

6. Compare the molecules H₂ and HF.
   a. How are they similar?
      
      2 atoms attached

   b. Which one has a molecular dipole?
      HF

   c. Which molecule is nonpolar?
      H₂

   d. Which molecule is polar?
      HF

   e. What makes them different?
      HF has 2 different atoms with
      different electronegativities
      H₂ has 2 identical atoms with identical electronegativities
7. Compare the molecules CH₂F₂ and CH₄.
   a. How are they similar?
      \[ \text{X} \text{ carbon is central + both have 4 atoms attached} \]
   b. Which one has a molecular dipole?
      \[ \text{CH₂F₂} \]
   c. Which molecule is nonpolar?
      \[ \text{CH₄} \]
   d. Which molecule is polar?
      \[ \text{CH₂F₂} \]
   e. What makes them different?
      \[ \text{CH₄} \text{ has even pull on central carbon but CH₂F₂ does not} \]

8. Compare the molecules H₂O and CO₂.
   a. How are they similar?
      \[ \text{both have 2 bond regions} \]
   b. Which one has a molecular dipole?
      \[ \text{H₂O} \]
   c. Which molecule is nonpolar?
      \[ \text{CO₂} \]
   d. Which molecule is polar?
      \[ \text{H₂O} \]
   e. What makes them different?
      \[ \text{H₂O has 2 lone pairs but CO₂ does not have any} \]

9. Compare the molecules BH₃ and NH₃.
   a. How are they similar?
      \[ \text{they both have 3 H's attached to central atom} \]
   b. Which one has a molecular dipole?
      \[ \text{NH₃} \]
   c. Which molecule is nonpolar?
      \[ \text{BH₃} \]
   d. Which molecule is polar?
      \[ \text{NH₃} \]
   e. What makes them different?
      \[ \text{NH₃ has a lone pair but BH₃ does not} \]

10. Examine HCN. Is the molecule polar or nonpolar?
    \[ \text{H - C \equiv N: polar} \]
    a. Which atom has the higher density of electrons, N or H?
       \[ \text{N} \]

11. Determine a rule for determining if a molecule is polar or nonpolar.
    - if the bond dipoles around a central atom cancel it is nonpolar (does not have poles)
    - if the bond dipoles around a central atom do not cancel it is polar (has poles)